REMARKS

The Examiner has objected to the Specification due to informalities. Applicant respectfully asserts that the objection is avoided due to clarifications made hereinabove to the Specification.

The Examiner has rejected Claims 1-33 under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. Specifically, the Examiner argued that the 'specification does not appear to describe "enhancing graphics pipeline operations".' Applicant respectfully asserts that support may be found on page 19, lines 11-15 as well as former Claims 32-33, which are also clearly supported by the originally filed specification.

Further, the Examiner has rejected Claims 1-33 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicant respectfully asserts that the rejection is avoided in view of the amendments made to the independent claims.

The Examiner has rejected Claims 1-25, 28-29, and 32-33 under 35 U.S.C. 101 being directed to non-statutory subject matter. Applicant respectfully asserts that the rejection is avoided in view of the amendments made to the independent claims. Specifically, applicant asserts that "the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes," in the manner claimed, thus clearly producing a tangible result. In addition, with respect to Claims 10 and 11, applicant respectfully asserts that the techniques "wherein the local area of textures is filtered utilizing a filter including a plurality of elements (see Claim 10 – emphasis added) and "wherein the local area of textures is used to sample a texture map to generate a modified local area of textures" (see Claim 11 – emphasis added) both produce a tangible result. It should also be noted that the various method claims have each been amended to require a "hardware graphics pipeline-implemented method" (emphasis added).

The Examiner is thanked for the allowable subject matter of Claims 10 and 11. The Examiner has objected to Claims 10 and 11 as being dependent upon a rejected base claim. The Examiner further stated that Claims 10 and 11 would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims, along with the correction of other outstanding rejections. Applicant notes that Claims 10 and 11 have been rewritten in independent form along with the limitations of any intervening claims, and any remaining rejections have been addressed.

The Examiner has rejected Claims 1-2, 12-18, 22-23, 27, and 32-33 under 35 U.S.C. 103(a) as being unpatentable over Press (Press, William H.; Flannery, Brian P.; Teukolsky, Saul A.; Vetterling, William T.; "Numerical Recipes in Fortran 77", 2001, Second edition, Cambridge University Press) in view of Trendall (Trendall, Chris; Stewart, A. James; "General Calculations using graphics hardware, with application to interactive caustics", June 2000, "Rendering Techniques 2000: 11th Eurographics Workshop on Rendering"). Applicant respectfully disagrees with such rejection, especially in view of the amendments made hereinabove to the independent claims. Specifically, applicant has amended the above rejected independent claims to at least substantially include the subject matter of former dependent Claims 32 and 33.

With respect to the independent claims, the Examiner has relied on Page 9, section 5, first paragraph; Page 7, second paragraph; Page 1, Title; Page 1, Abstract; Page 1, section 1; Page 8, section 4.2; and Page 2, section 2.2 from the Trendall reference to make a prior art showing of applicant's claimed "processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline" (see this or similar, but not necessarily identical language in the independent claims).

Applicant respectfully asserts that the excerpts from the Trendall reference relied upon by the Examiner merely teach "[g]eneral calculations using graphics hardware" (Page 1, Title) to "accelerate the rendering process much earlier than at the latter image generation stages" (Page 1, Abstract). In particular, Trendall suggests that "an RGB or

RGBA image can represent a three or four dimensional vector field defined over a subset of the plane" which is beneficial since "operations on an image are highly parallelized and calculations on entire functions or vector fields can be performed very quickly in graphics hardware" (Page 3, Section 3). However, these general calculations of the cited excerpts simply fail to disclose "processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

In the Office Action mailed 06/16/2006, the Examiner argued that "the Trendall reference clearly teaches that graphics hardware is useful for general mathematical calculation, not just to accelerate the rendering process." Applicant respectfully asserts that Trendall merely teaches that "[g]eneral mathematical operations can be built on the hardware capabilities described..." (Section 3.2, first paragraph) and that "[t]his paper considers the limitations of current hardware and discusses potential improvements that could greatly accelerate a more general set of calculations **commonly used in graphics**" (section 1, third paragraph – emphasis added). In addition, Trendall discloses that "[t]his paper has shown that graphics hardware can be used to perform complex general calculations...[a]lthough the calculation is clearly not as precise as a floating point implementation" (section 6, first paragraph – emphasis added). Clearly, the mere disclosure in Trendall of accelerating a general set of calculations commonly used in graphics within the limitations of the current hardware fails to even suggest "processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

Additionally, in the Office Action mailed 06/16/2006, the Examiner argued that "a caustic is a solution to a partial differential equation." Applicant respectfully asserts that Trendall discloses that "approximations [are] necessary to implement caustic generation in hardware" and that there are "significant approximations involved [in] integration as current hardware is equipped with only a relatively small convolution kernel for implementing this operation" (section 6, fourth paragraph – emphasis added). Clearly, the mere disclosure that approximations are necessary to implement caustic

generation and integration fails to even suggest "generat[ing] the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

Furthermore, Trendall suggests using "a continuous approximation to the spreading of light after refraction, which leads to an integral that can be discretized" (Page 3, Section 2.2 – emphasis added) and that "the heightfield normals are calculated by convolving to get the x and y discrete partial derivatives, and then using pixel texturing to look up the associated normal" (Page 8, Section 4.2). Trendall's suggestion of calculating heightfield normals by convolving clearly fails to meet "processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

In the Office Action mailed 06/16/2006, the Examiner argued that "[c]alculation of a caustic does process the input to generate the solution to a partial differential equation, because a caustic is a solution to a partial differential equation." Applicant respectfully asserts that Trendall teaches the use of "*convolutions* with limited kernels [which] can be computed directly; [and that] derivatives of height fields can be computed either by convolution [27] or by blending in the accumulation buffer [2]" (section 3.2, second paragraph - emphasis added). Further, Trendall discloses that "a number of approximations must be made in order to achieve real-time performance" and that "the integral of equation (2) can be approximated efficiently by phrasing it as a convolution" (section 4.1, Discretization and Approximation, first and third paragraphs – emphasis added). Additionally, Trendall teaches that "[i]n *Pass 1*, the heightfield normals are calculated by convolving to get the x and y discrete partial derivatives, and then using pixel texturing to look up the associated normal" (section 4.2, third paragraph – emphasis added). However, the mere disclosure of using convolutions to efficiently approximate integrals of equations and to calculate heightfield normals which result in the x and y discrete partial derivatives fails to even suggest "processing the input to generate the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant. Clearly, Trendall's reliance on convolving to

approximate integrals and generate discrete partial derivatives fails to even suggest "generat[ing] the solution to the partial differential equation utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

Further, with respect to the independent claims, the Examiner has relied on Page 1, Abstract; Page 1, section 1; Page 8, section 4.2; and Page 2, section 2.2 from the Trendall reference to make a prior art showing of applicant's claimed technique "wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline" (see this or similar, but not necessarily identical language in the independent claims). For similar reasons to those argued hereinabove, applicant respectfully asserts that the excerpts from Trendall relied upon by the Examiner simply fail to even suggest a technique "wherein the solution to the partial differential equation is generated utilizing the hardware graphics pipeline for enhancing graphics processing operations performed by the hardware graphics pipeline" (emphasis added), as claimed by applicant.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed.Cir.1991).

With respect to the first element of the *prima facie* case of obviousness, the Examiner states that "the motivation to use the art of Trendall with the art of Press would have been the benefit recited in Trendall that calculations on functions or vector fields

can be performed very quickly in graphics hardware." Applicant respectfully disagrees with this proposition, especially in view of the vast evidence to the contrary.

For example, Press relates to implementing mathematics in software, while Trendall relates to graphics hardware that implements different mathematics. To simply glean features from graphics hardware that implements different mathematics, such as that of Trendall, and combine the same with the *non-analogous art* of software-implemented mathematics, such as that of Press, would simply be improper. Graphics hardware implements mathematics in a hardware environment for improving hardware graphics processing, while software-implemented mathematics merely relates to using software to carry out mathematic operations. "In order to rely on a reference as a basis for rejection of an applicant's invention, the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the inventor was concerned." In re Oetiker, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992). See also In re Deminski, 796 F.2d 436, 230 USPQ 313 (Fed. Cir. 1986); In re Clay, 966 F.2d 656, 659, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992). In view of the vastly different types of problems software-implemented mathematics addresses as opposed to graphics hardware-implemented mathematics, the Examiner's proposed combination is clearly inappropriate.

In addition, in the Office Action mailed 06/16/2006, the Examiner argued that "an ordinary artisan at the time of invention would have known that the software mathematics of Press was implemented on hardware, and therefore, the art of Press also related to hardware-implemented mathematics" and that "the Trendall reference clearly teaches that graphics hardware is useful for general mathematical calculation." Applicant respectfully asserts that the software mathematics of Press is implemented using "Fortran 77" (see Title) and not directly on the hardware. For example, Page 860 of Press discloses implementing "a routine for SOR with Chebyshev acceleration" in Fortran. Further, Trendall discloses that the when the software implementation and hardware implementation were compared, the "relative RMS error between the two caustics was 26%" (section 5.2, first paragraph). Clearly, hardware-implemented mathematics and

software-implemented mathematics present different problems as evidenced by the 26% relative RMS error between the two implementations. Again, applicant respectfully asserts that the Examiner's proposed combination is clearly inappropriate in view of the vastly different types of problems addressed by software-implemented mathematics as opposed to those addressed by graphics hardware-implemented mathematics.

Further, by virtue of the sole focus of Press on software-implemented general mathematics, it is further argued that Press *teaches away* from the graphics hardware-oriented mathematics of Trendall and the claimed invention. *In re Hedges, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986).*

In the Office Action mailed 06/16/2006, the Examiner argued that "Press teaches hardware implemented mathematics, and so does not teach away from hardware oriented mathematics." Further, the Examiner argued that "the teachings of Press do not criticize, discredit, or otherwise discourage hardware implemented mathematics, and therefore cannot be held to teach away from hardware implemented mathematics." Applicant respectfully disagrees with the Examiner's argument that Press teaches hardware-implemented mathematics. Clearly, the mere disclosure of Press of implementing "Numerical Recipes in Fortran 77" and that "[t]he software [in the book] may be downloaded ... from the Numerical Recipes Software Web Site (http://www.nr.com)" (Title, and Copyright page) teaches software-implemented mathematics. Clearly, the software-implemented mathematics of Press fail to teach the use of the graphics hardware-implemented mathematics of Trendall and the claimed invention, contrary to the Examiner's statements made in support of the above arguments.

Applicant respectfully asserts that it would have been *unobvious* to incorporate the partial differential equations from Press in the graphics hardware environment of Trendall, since only applicant has recognized the benefits of the same. Specifically, solutions to partial differential equations, in the graphics hardware environment context claimed by applicant, provide numerous *optional* advantages such as providing for more effective determination of a location of objects or surfaces to be rendered (as well as

other possible advantages, etc.). Note the originally filed specification. Only applicant teaches and claims such a combination of features and components for the generation or computation of partial differential equation solutions for such purpose.

In the Office Action mailed 06/16/2006, the Examiner argued that "the rejection of claim 1 ... demonstrates that it would have been obvious to use the art of Trendall with the art of Press to produce the claimed invention." Applicant respectfully disagrees with the Examiner's argument for the reasons argued hereinabove with respect to the independent claims.

Applicant respectfully asserts that at least the first and third element of the *prima facie* case of obviousness has not been met, as noted above. Nevertheless, despite such paramount deficiencies and in the spirit of expediting the prosecution of the present application, applicant has incorporated the subject matter of former Claims 32 and 33 into the rejected independent claims.

With respect to the subject matter of former Claim 32 and 33 (now at least substantially incorporated into the rejected independent claims), the Examiner has relied on Page 8, section 4.3 from the Trendall reference to make a prior art showing of applicant's claimed technique "wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline" (see this or similar, but not necessarily identical language in such independent claims).

Specifically, the Examiner argued that "a heightfield is a solution to a partial differential equation and is a surface rendered" and "an object rendered." Applicant respectfully disagrees and asserts that section 4.3 in Trendall discloses that "the real time generation of a height field ... represents the surface of the pond." In addition, section 4.2 in Trendall discloses that "[i]n *Pass 1*, the heightfield normals are calculated by convolving to get the x and y discrete partial derivatives, and then using pixel texturing to

look up the associated normal" (emphasis added). Clearly, the mere disclosure of using convolving to calculate the heightfield normals which result in the x and y discrete partial derivatives, and then looking up the associated normal using pixel texturing which represents the surface of the pond fails to even suggest a technique "wherein the graphics processing operations performed by the hardware graphics pipeline are enhanced by determining a location of surfaces or objects for rendering purposes utilizing the solution to the partial differential equation generated utilizing the hardware graphics pipeline" (emphasis added), as claimed by applicant.

Thus, a notice of allowance or specific prior art showing of each of the foregoing claim elements, in combination with the remaining claimed features, is respectfully requested. To this end, all of the independent claims are deemed allowable. Moreover, the remaining dependent claims are further deemed allowable, in view of their dependence on such independent claims.

In the event a telephone conversation would expedite the prosecution of this application, the Examiner may reach the undersigned at (408) 505-5100. The Commissioner is authorized to charge any additional fees or credit any overpayment to Deposit Account No. 50-1351 (Order No. NVIDP074).

Respectfully submitted,
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